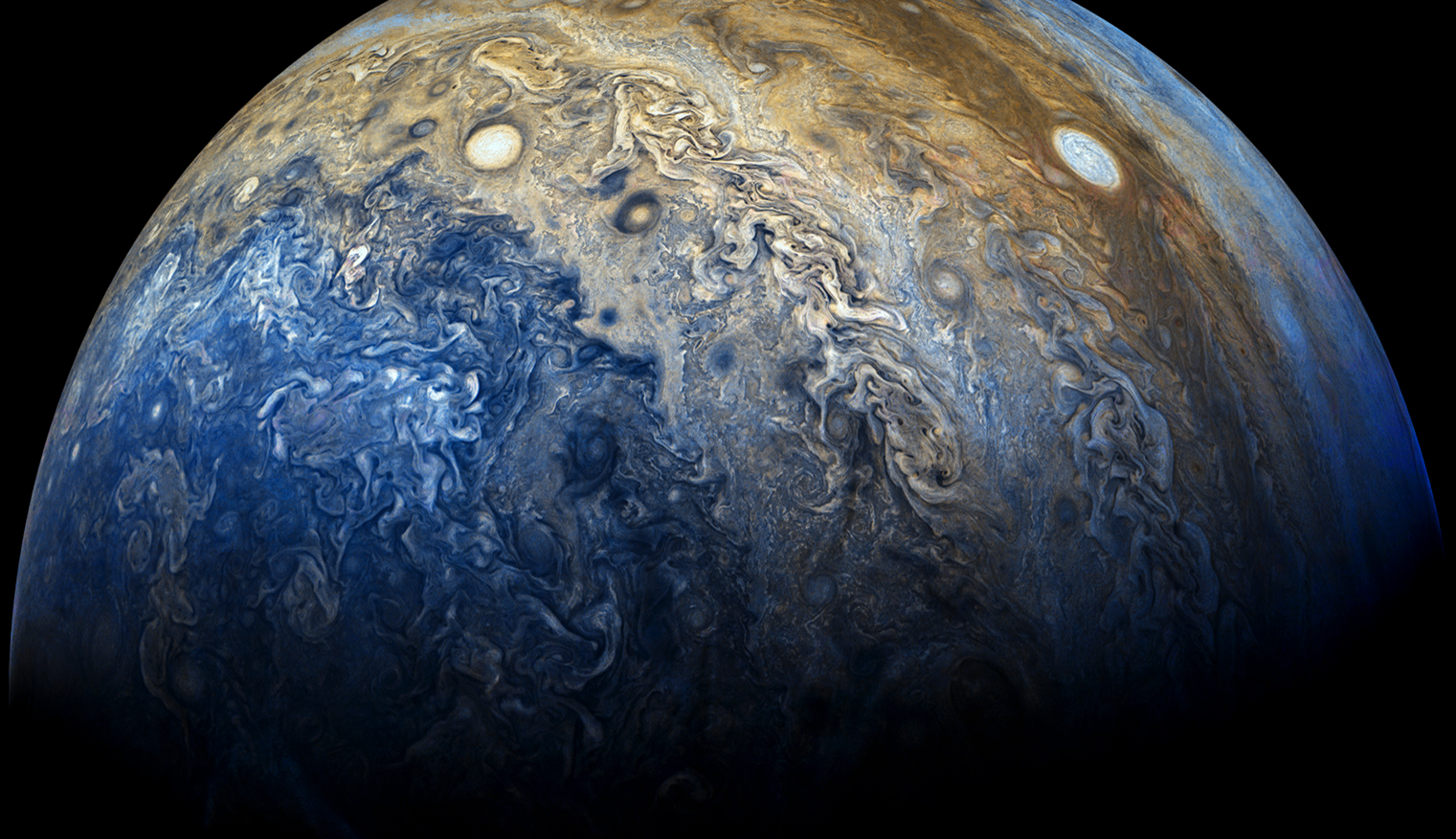


NASA / SwRI / MSSS / Gerald Eichstädt / Seán Doran

Impact of the Advanced Water Vapor Radiometer on the Juno Gravity Science Investigation

Dustin Buccino, Marzia Parisi, Daniel Kahan, Meegyeong Paik, Oscar Yang, Kamal Oudrhiri
Planetary Radar and Radio Sciences Group

William Folkner
Solar System Dynamics Group

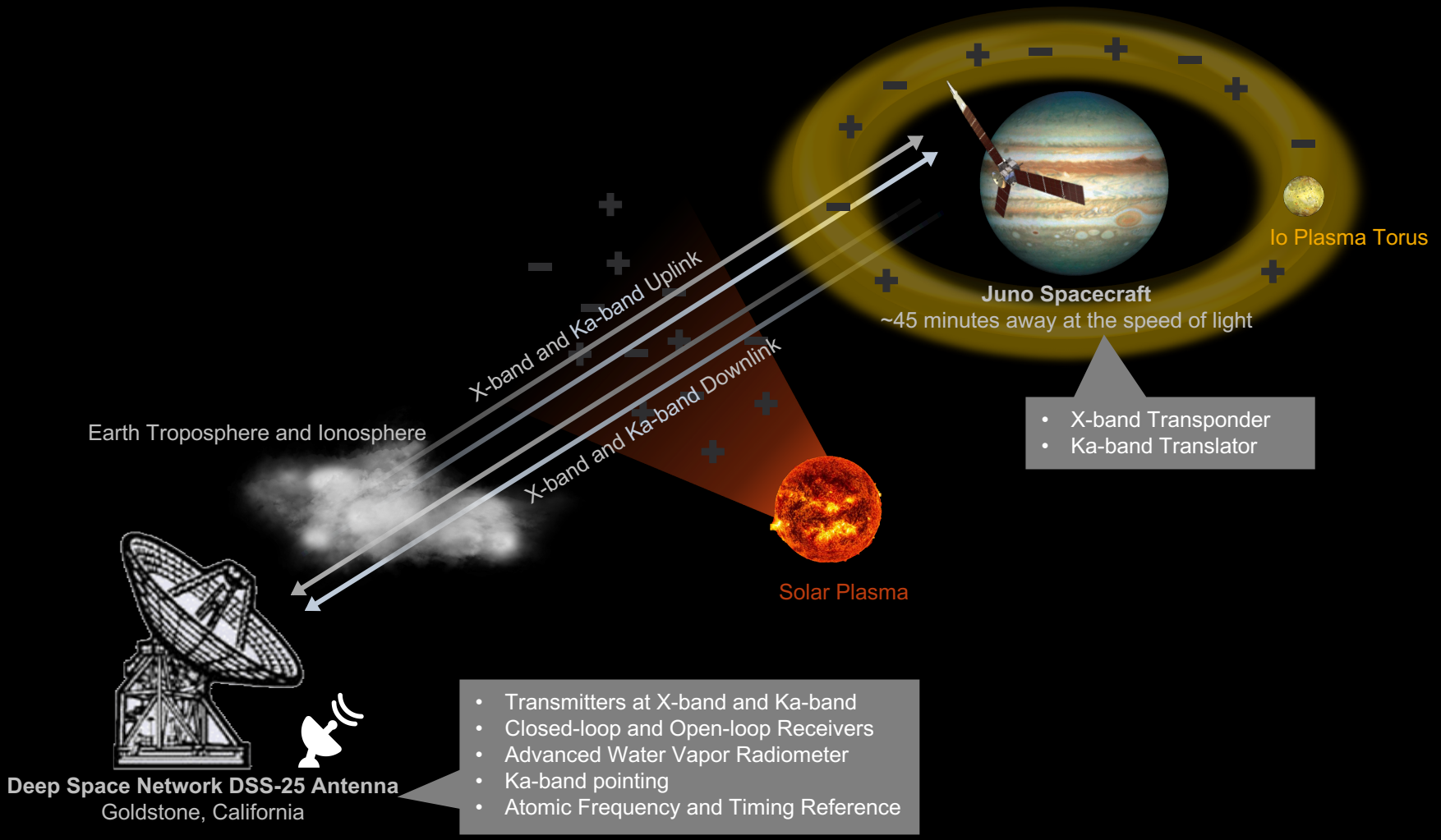
Jet Propulsion Laboratory, California Institute of Technology

Jet Propulsion Laboratory
California Institute of Technology

Introduction

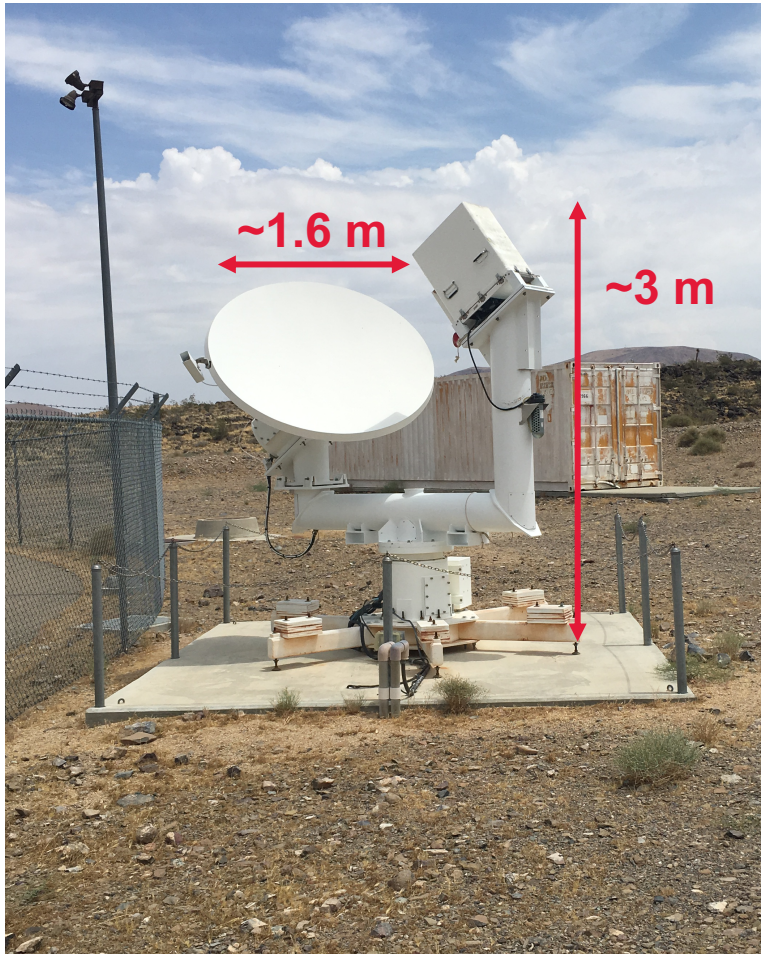
1. Juno Gravity Science Investigation
2. The Advanced Water Vapor Radiometer (AWVR)
3. Limitations and Constraints of the AWVR
4. Application to Juno
5. Results

Measuring Jupiter's Gravity Field



The Advanced Water Vapor Radiometer

- The AWVR measures sky brightness temperatures at the 22.2, 23.8, and 31.4 GHz spectral lines
- Radiometer data combined with ancillary data from microwave temperature profiler (MTP) and surface meteorology (SURFMET) to produce zenith-equivalent dry and wet delays
- Two units built for Cassini Gravity Wave (GWE)



Limitations and Constraints

I. Hardware Stability / Thermal Noise

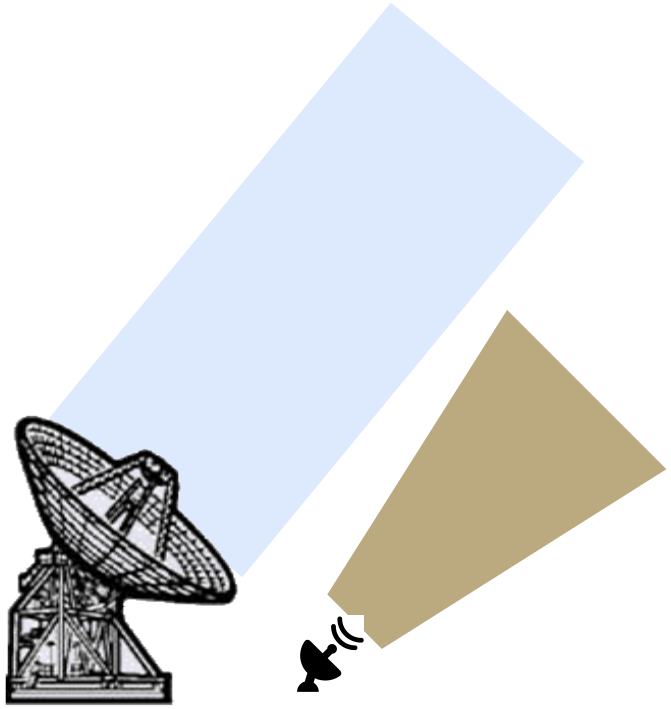
II. Beam Offset

III. Beam Mismatch

IV. Emission Model

V. Retrieval / Inverse Algorithm

VI. Dry Troposphere Contribution



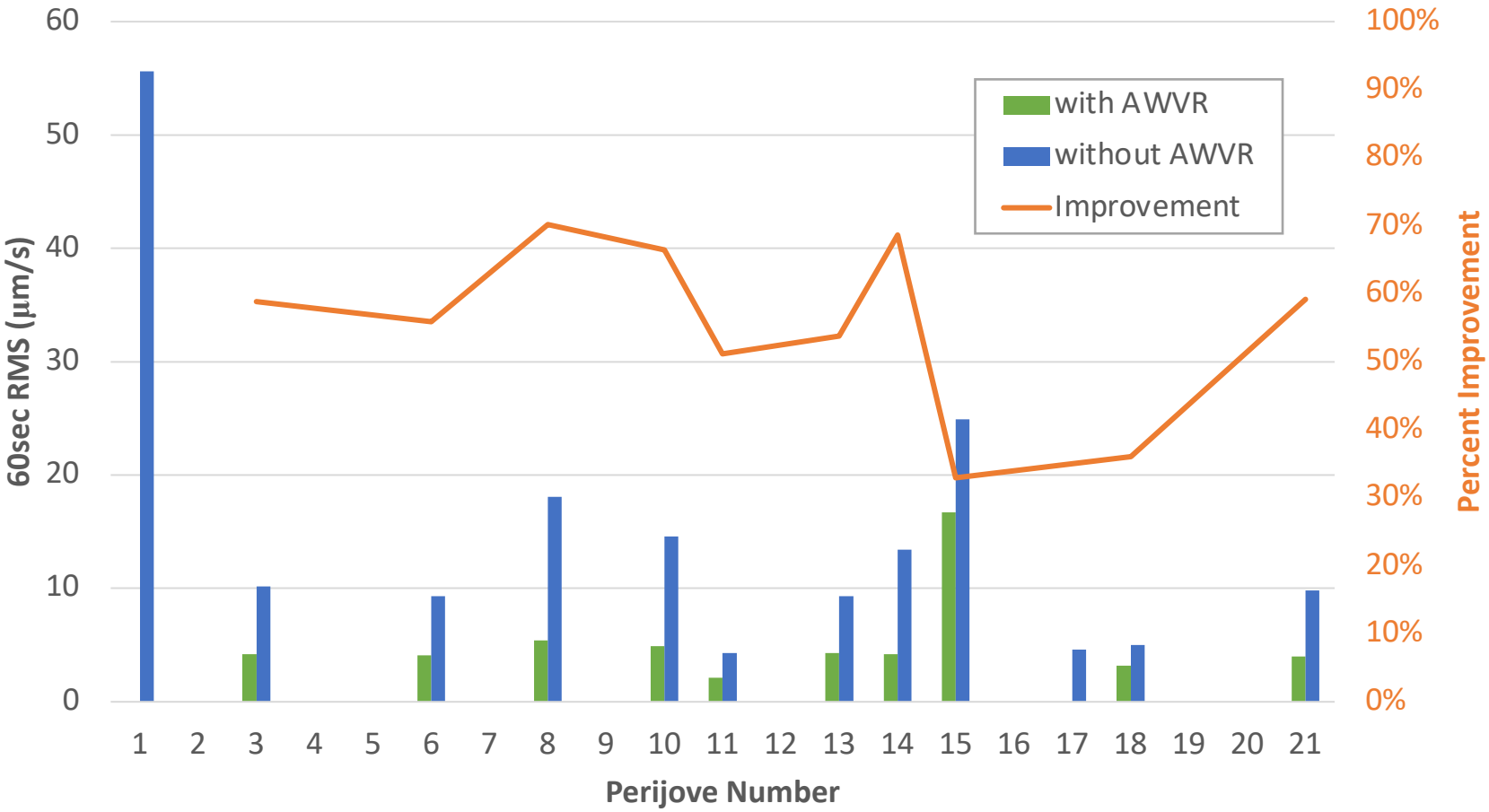
Linfield, *Error Budget for WVR-based Troposphere Calibration System,* 1996.
Linfield and Wilcox, *Radiometric Errors due to Mismatch and Offset…,* 1993.
Tanner and Riley, *Design and performance of a high-stability water vapor radiometer*, 2003.
Keihm and Marsh, *Advanced Algorithm and System Development for Cassini Radio Science Tropospheric Calibration*, 1996.

Application to Juno

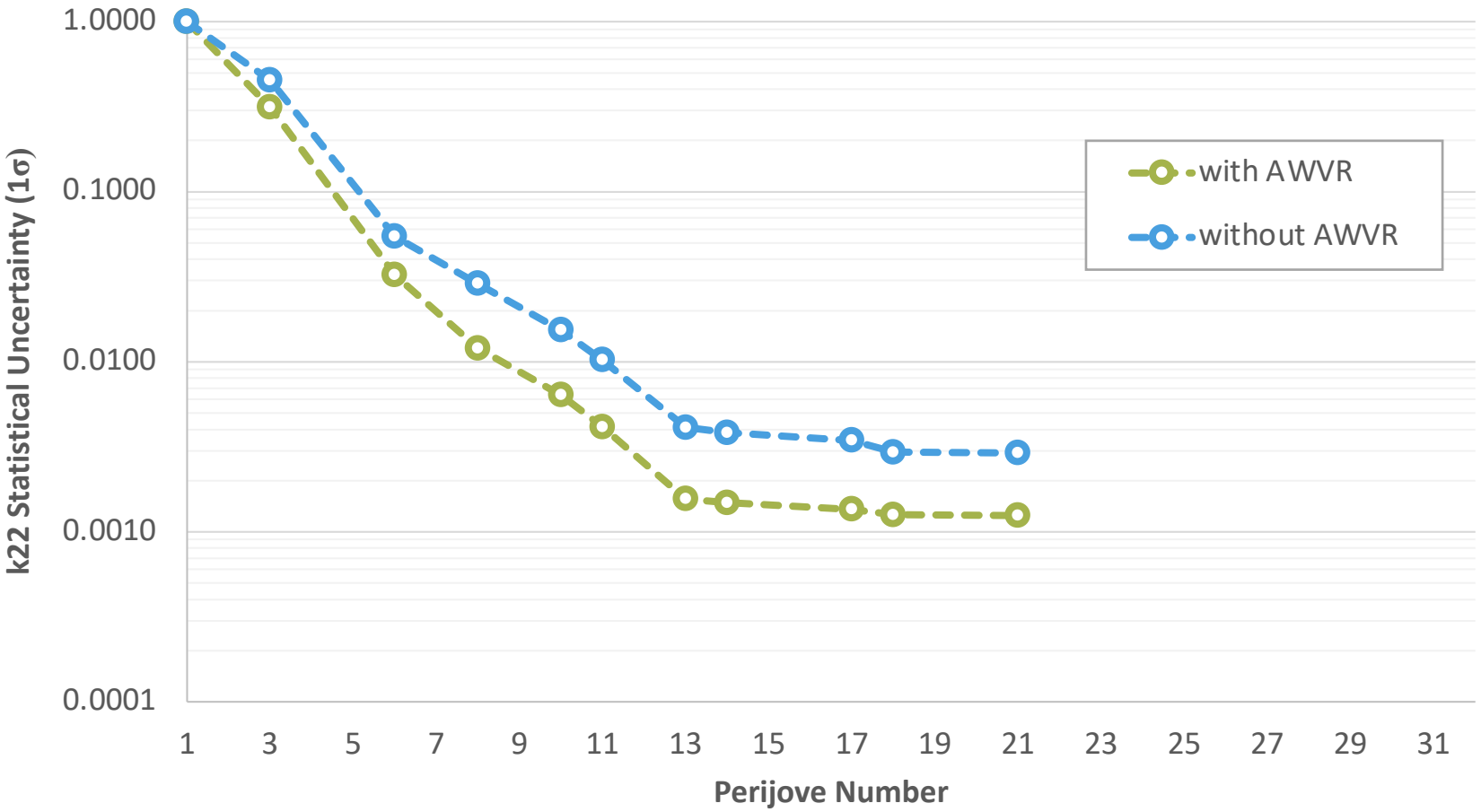
- AWVR “rule of thumb” integration time of 30 seconds minimizes thermal noise while maintaining enough time resolution

- Aging and failing equipment
  - The two AWVR units are over 20 years old; second unit in Madrid brought back to Goldstone in 2016 as backup unit
  - Consistent and vigilant maintenance required
  - Ancillary calibration equipment:
    - Microwave Temperature Profiler (MTP) occasional failures; different path delay retrieval algorithms required
    - Surface meteorology package (SURFMET) non-functional in 2017; data replaced with Goldstone complex weather station

Juno Perijove Ka/Ka Residual Statistics

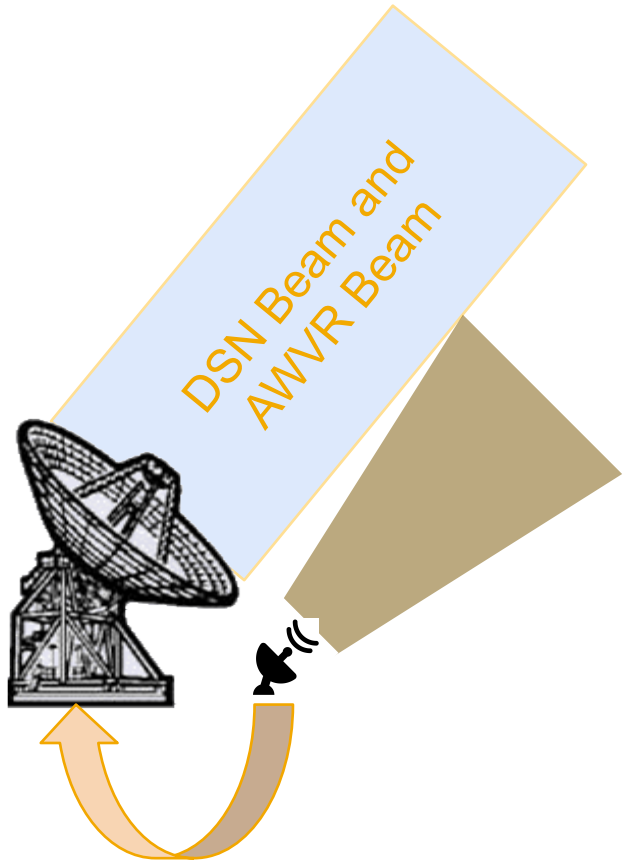


Jupiter Love Number (k_{22}) Uncertainty



Conclusions

- The AWVR has improved the Juno Gravity Science Doppler measurements by ~55% on average and >70% in optimal conditions
- The AWVRs are aging, require constant maintenance and repair
- Future research and development work at JPL to integrate radiometers into the BWG itself *



* Jongeling, A., Tanner, A., Border, J., Long, E., & Lin, H. (2018, December). In-line Water Vapor Radiometer for Precision Deep Space Doppler Tracking. In *AGU Fall Meeting Abstracts*.

Jet Propulsion Laboratory
California Institute of Technology

jpl.nasa.gov